# EQUIPMENT

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## UPGRADE OF PROPORTIONING COLORANT AND DECOLORIZING AGENTS FOR GLASS BATCH

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Different designs of proportioners and screw feeders for colorant and decolorizing agents for glass melt are discussed.

In 2003 the Borskii Glass Works, which is one of the largest Russian manufacturers of automobile and construction glass, started producing tint glass with decreased thermal conductivity. The concentration of colorants in the new grade of green glass was designed according to the recommendations of potential customers, including the Gorkovskii, Ul'yanovskii, Volzhskii, Izhevskii automobiles works, and the Ford factory in Vsevolzhsk (Leningrad Region).

One of the technological requirements on melting tint glass was the introduction of columite slag [1] and iron oxide in the glass batch composition. Although the beam balance dosing units that were previously used for dosing iron oxide on two proportioning-mixing lines at the Borskii glass works included a strain-gage checking device, they do not meet current requirements on weighing precision and batch quality.

New strain-gage weighing proportioners developed and produced by the Stromizmeritel' JSC were integrated into the existing automated control system for batch preparation without stopping the production process.

The design of the proportioner (Fig. 1) includes supply bunker 1; soft airtight sleeve *2*, charge screw feeder *3* with a constant lead of the screw; transitional shelter *4* with peepholes *5*; floor frame *6* for installing the proportioner; strain-gage weighing suspension *7* consisting of three strain-gage transducers; weighing hopper *8* with a platform for calibration weights; discharge screw feeder *9* with a variable pitch; transition shelter *10* with peepholes *11* for manual sampling of material proportioned; and airtight sleeve *12* connecting the proportioner with assembly conveyor belt *13*.

Geared motors produced by Bonfiglioly (Italy) that have high reliability and optimum cost-quality ratio are used as electric drives for the charge and discharge screw feeders.

The performance of the proportioner is based on variable-container weighing taking into account accidental overweight and possible sticking of material to the discharge feeder and the weighing hopper walls [2]. Using this method, material is charged into the proportioner using the feeder with constant screw parameters, whereas discharge is performed by the screw feeder with the variable pitch. Using this feeder, the material is initially discharged from the weighing hopper in the "rough" mode by both segments of the screw. Eventually a moment comes when, due to different efficiency, the material above the long-pitch feeder segment is totally unloaded, whereas some residual material persists above the short-pitch screw and is unloaded in the "precise" discharge mode (RF patent No. 2117640).

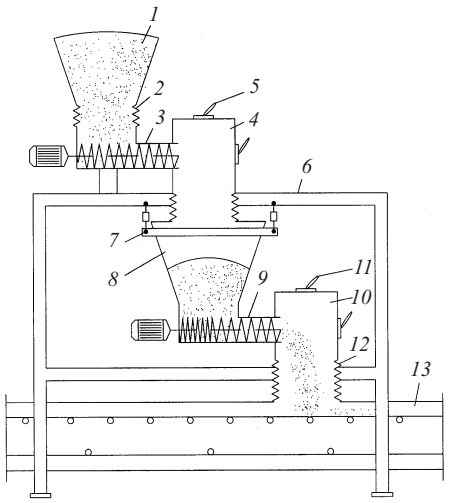


**Fig. 1.** Iron oxide proportioner.

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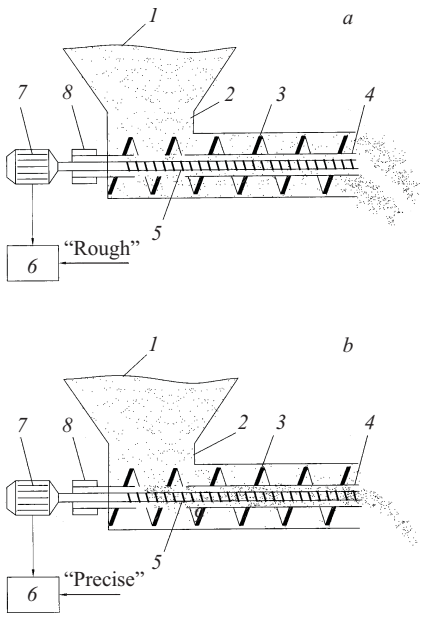


**Fig. 2.** Two-screw small-dose feeder for glass batch components.

Since the technology of tinting glass melt in light green or dark green colors involves introducing different quantities of iron oxide, the lowest dosing limit (LDL) for this weigher is 5 – 9 kg and the highest dosing limit (HDL) is 50 – 60 kg. Amounts of 5 – 9 and 15 – 20 kg iron oxide are used to prepare 2 tons of batch for light green and dark green glass, respectively, whereas 20 and 60 kg of colorant, respectively, is introduced into the glass batch as a dopant accelerating the transition from a clear glass melt to a green melt. The transition lasts 25 – 40 h.

It is obvious that with the same absolute weighing error depending on the design parameters of the particular proportioner, the relative proportioning error in the range of the LDL can be several times higher than in the HDL range, if the ratio of the HDL to the LDL is 7 – 10. Therefore, the initial testing of an iron oxide dosing weigher with a discharge feeder of constant diameter and constant screw pitch did not show good results, since the relatively low proportioning rate under the required precision in the LDL range did not provided for the required discharge efficiency in the HDL range. To eliminate this contradiction, it was necessary to promptly produce and install a screw feeder with a variable pitch (60 mm on the rough proportioning segment and 20 mm on the precise proportioning segment).

After the feeder was replaced, the mean error in dosing a 10-kg portion of iron oxide was 0.10 – 0.15% according to the data from the automatic control system of batch preparation, while the required efficiency was provided, and after the dosed portions were weighed on a control scale, the error was found to be not higher than 0.06%.

A similar proportioner with slight design modifications has been installed for dosing decolorizing agents on the batch preparation line for melting household glass at the Posuda Company (town of Bor).

A further increase in the accuracy of dosing colorant and decolorizing agents can be achieved by using various designs of double-screw charge and discharge feeders [3, 4]. For instance, a proportioner for raw materials [4] contains a vertical supply bunker, a blade mixer, and a discharge screw feeder of large diameter, whereas the additional-charge screw of small diameter is installed coaxially inside the hollow shaft of the discharge feeder. In this case each feeder has an independent electric drive and the same direction of the screw coiling.

The disadvantage of this design is the presence of two drives and the fact that precise weighing can be performed only after the hollow shaft is completely filled by the mixer during the rough proportioning.

The Stromizmeritel' JSC has developed a more perfect design of a two-screw feeder for small components of the glass batch with coaxial alignment of screw feeders of large and small diameters. The distinction of this technical solution from other known solutions is that the coiling direction of the large-diameter screw feeder is opposite to the coiling of the small-diameter feeder; therefore, the transition from the rough dosing mode to precise dosing is performed by simple reversal of the electric drive (RF patent No. 2213709, priority 26.12.2001).

The feeder works in the following way (Fig. 2*a* ). Material from supply hopper *1* under the effect of gravity is transported to receiving hopper *2*, which contains large-diameter screw feeder *3* and inside the hollow shaft *4* of the latter there is small-diameter screw feeder *5* (the output ratio of the two feeders is 50 : 1). After a "rough mode" command, reversing-type starter *6* switches on drive *7* and makes its shaft with coaxially aligned screw feeders rotate clockwise. The rotation to the small-diameter feeder is transmitted directly from the drive and to the large-diameter feeder via overrunning clutch *8*. As the drive shaft rotates clockwise, feeder *3*, in accordance with the direction of its screw coiling, transports the material from the receiving hopper to the exit branch pipe. At the same time, feeder *5* due to the opposite direction of its screw coiling transports the material (if there is any left from the preceding cycle) in the opposite direction.

After the end of rough proportioning (90 – 95% of the material portion) the "Rough mode" command is canceled and the "Precise mode" command issued to reversing-type starter *6* (Fig. 2*b* ).

The main drive shaft *7*, on which the small-diameter feeder is installed, starts rotating counterclockwise and the material inside the hollow shaft moves toward the exit branch pipe, thus ensuring the precise charging mode. In this case the rotation is not transmitted to the large-diameter screw feeder via the overrunning clutch.

At the end of the cycle, the "Precise" command is cancelled and the small-diameter screw feeder stops feeding material.

Thus, the use of a two-screw feeder with an overrunning clutch and a coaxial alignment of screws with different diameters and different coiling pitch make it possible to raise the efficiency and significantly decrease the error in a wide range of proportioning small glass batch additives.

Furthermore, the different directions of the screw coiling and the mode of reversing their rotation provide for a two-velocity feed of material using a single-velocity drive, which simplifies the control system and lowers its cost.

A similar kind of two-screw feeder is now being used in designs for batch-preparation divisions at the Zippe Company (Germany).

## REFERENCES

1. V. V. Efremenkov and K. Yu. Subbotin, "Improvement of proportioning friable components of glass batch," *Steklo Mira*, No. 3, 49 – 50 (2003).
2. V. V. Efremenkov, V. N. Berezin, V. S. Rozhkov, et al., "Improvement of proportioning friable components of glass batch," *Steklo Keram.*, No. 3, 7 – 9 (1996).
3. V. V. Efremenkov and K. Yu. Subbotin, "Control of efficiency of screw feeders for glass batch components," *Steklo Keram.*, No. 10, 3 – 4 (2004).
4. A. V. Katalymov and V. A. Lyubartovich, *Proportioning of Friable and Viscous Materials* [in Russian], Khimiya, Leningrad (1990).